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# Design and Analysis of High Rise Building under Different Types of Soil Condition with and without Shear Wall using ETABS Software

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**ABSTRACT** : The structural system of a high-rise building with Shear walls are lateral load resisting structural systems which provide stability to structures from lateral loads like wind and seismic Loads. The design of multi-storey building it is generally constructed on assumed that underlying soil are Hard, Medium and Soft. A Multi-storey building with RC-Shear wall is to have good lateral load resisting System along with gravity load system for safety of occupant and for better performance of structure even in most adverse condition. As a result the accuracy in assessing structural safely during earthquake cannot be accounted accurately. So investigation of energy transfer mechanism from soils to buildings during earthquake is vital for the design of earthquake resistant structures and for retrofitting existing structures. Hence the soil -structure interaction analysis of framed structures is the main focus of this study. The effects of soil-structure interaction are analyzed for typical multi- storey building resting on different soils. In Our Project contains a brief description and analysis of Symmetrical frame having 30 storey building with shear wall and without shear wall with different types of soil condition for highly seismic area i.e. zone-5, thoroughly discussed structural analysis of a building to explain the application of shear wall. The design analysis of the multi storied building in our project is done through software ETABS.

**KEYWORDS** : SHEAR WALL , EARTHQUAKE ANAYLSIS , COLUMN , TIME PERIOD, SOIL CONDITIONS,

## I.INTRODUCTION

Reinforced concrete framed buildings are adequate for resisting both vertical and the horizontal loads acting on them. When the buildings are tall say more than 10 storey's or so, beam and column sizes work out large reinforcement at beam-column junctions works out quite heavy, so that there is a lot of congestion at these joints and it is difficult to place and vibrate concrete at these places, which fact, does not contribute to the safety of buildings. These practical difficulties call for introduction of shear wall in multi-story buildings. A shear wall is a structural element used to resist lateral/horizontal/shear force parallel to the plane of wall is called shear wall.

- Shear wall resist the lateral or horizontal force by cantilever action for slender wall where bending deformation is dominant.
- Shear wall resist the lateral or horizontal force by truss action for short wall where shear deformation is dominant.

In India most of the structures are low rise buildings. Now a days due to greater migration towards cities, results in increase in the population in most of the major cities. In order to fulfill the requirement of this increased population in limited land the height of building becomes medium to have high rise buildings. The improper design and construction of building may cause great destruction of structures all over the world. Hence, we have to be concerned about the safety against the earthquake forces that are affecting the structures. The major factor is the asymmetry of the building the asymmetry contributes significantly for translational torsional coupling in the seismic responses which can lead to lateral deformation of the building. Buildings with asymmetric distribution of stiffness and strength in plan undergo coupled lateral and torsional motions during earthquake. . High-rise buildings were made practicable by the use of steel structural frames and glass exterior sheathing. By the mid-20th century, such buildings had become a standard feature of the architectural landscape in most countries in the world. The foundations of high-rise buildings must sometimes

support very heavy gravity loads, and they usually consist of concrete piers, piles, or caissons that are sunk into the ground. Beds of solid rock are the most desirable base, but ways have been found to distribute loads evenly even on relatively soft ground. The most important factor in the design of high-rise buildings, however, is the building's need to withstand the lateral forces imposed by winds and potential earthquake. Most high-rises have frames made of steel or steel and concrete. Their frames are constructed of columns (vertical-support members) and beams (horizontal-support members). Cross-bracing or shear walls may be used to provide a structural frame with greater lateral rigidity in order to withstand wind stresses. Even more stable frames use closely spaced columns at the building's perimeter, or they use the bundled-tube system, in which a number of framing tubes are bundled together to form exceptionally rigid columns.

### Stages in Structural Design

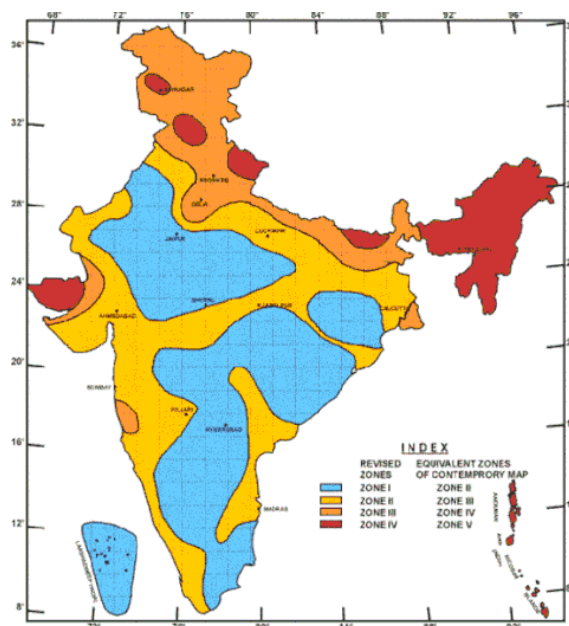
Every structure follows a specific path from its initiation to ultimate design as follows:

- 1) Structural planning of the building.
- 2) Calculation of applied loads.
- 3) Structural analysis of the building
- 4) Design of the building as per analysis.
- 5) Drawing and detailing of the structural members.
- 6) Preparation of tables and graphs.
- 7) It is the responsibility of the structural engineer to construct the building structurally good, considering all the loads acting on the building. There are so many methods of conducting this design we use E-tab software.

## II.OBJECTIVES

1. Modelling of 24 -storey building and application of different loads on ETABS.
2. The main objective is to check Seismic response on shapes of buildings via rectangular shape, and square shape in different Zones of India and design earthquake resistant multistoried building on that basis using ETABS software.
3. Seismic analysis of multi-storied building before construction work using ETABS software
4. Study of reactions, shear forces, axial force, bending moment, seismic forces and node displacement during assigning process and restrained them by applying suitable property and material in different zones.
5. Modelling of 25 storey building and application of different loads on ETABS load calculations due to different loading combinations analysis and design of structure on ETABS.
- 6.To analysis the building using IS code 1893 (part 1): 2002 for seismic analysis.
7. Compare the results coming from shear wall design and column design with seismic analysis.

### 3. SEISMIC ZONES





With the help of the past seismic history, Bureau of Indian Standards has grouped the country into four seismic zones namely,

Zone II: Low intensity zone-It covers about 40.93% area of the country. It consists of major parts of peninsular region and Karnataka Plateau.

Zone III: Moderate intensity zone-It covers about 30.79% area of the country. It consists of Kerala, Goa, Lakshadweep islands, remaining parts of Uttar Pradesh, Gujarat and West Bengal, Parts of Punjab, Rajasthan, Madhya Pradesh, Bihar, Jharkhand, Chhattisgarh, Maharashtra, Odisha, Andhra Pradesh, Tamil Nadu and Karnataka.

Zone IV: Severe intensity zone-It covers about 17.49% area of the country. It consists of parts of Jammu and Kashmir, Himachal Pradesh, National Capital Territory (NCT) of Delhi, Sikkim, Northern Parts of Uttar Pradesh, Bihar, West Bengal, parts of Gujarat, small portions of Maharashtra near the coast and Rajasthan.

Zone V: Very severe intensity zone-It covers 10.79% area of the country. It consists of the entire north-eastern India, parts of Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Rann of Kutch in Gujarat, part of North Bihar and Andaman & Nicobar Islands.

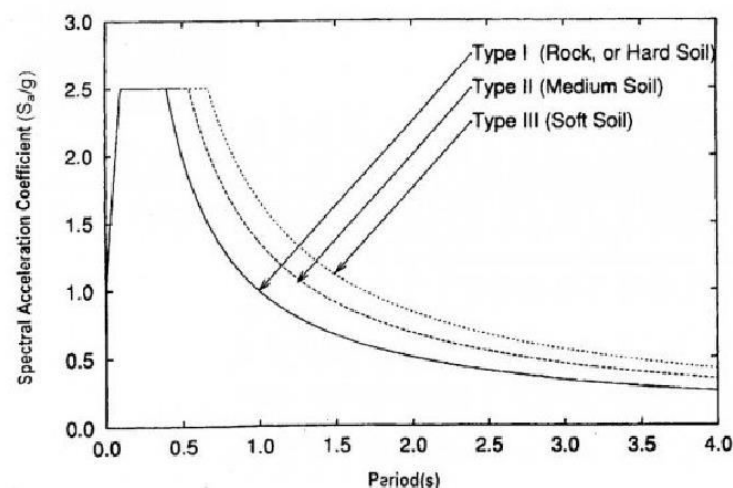
### III. SOIL TYPES

The soil type on which the structure lies can affect the stability of structure during seismic activity. The soil condition of the field is essential in analysis of the structures. Soil condition is defined as The physical condition of the soil and its dynamic properties which are divided according to IS 1893 table 2 into

Type A: It is composed of Rock or hard soils. It consists of well graded gravel (GW) or well graded sand both with less than 5 percent passing 75mm sieve. Well graded gravel- sand mixtures with or without fines (GW-SW). Poorly- graded sand (SP) or clayey sand 3 (SC), all having N having above 30. Stiff to hard clays having N above 30, where N is corrected Standard Penetration test value. Rock or Hard Soil: Well graded gravel and sand gravel and sand gravel mixtures with or without clay binder, and clayey sands poorly graded or sand clay mixtures (GB, CW, SB, SW, and SC) having N above 30, where N is the standard penetration value.

Type B: It is composed of Medium or stiff soils. It consists of poorly graded sands or poorly graded sands or poorly graded sands with gravel (SP) with little or no fines having N between 10 and 30. Stiff to medium stiff fine- grained soils, like of low compressibility (CL) having N between 10 to 30. Medium Soil All soils with N between 10 and 30, and poorly graded sands or gravelly sands with little or no fines (SP) with  $N > 15$

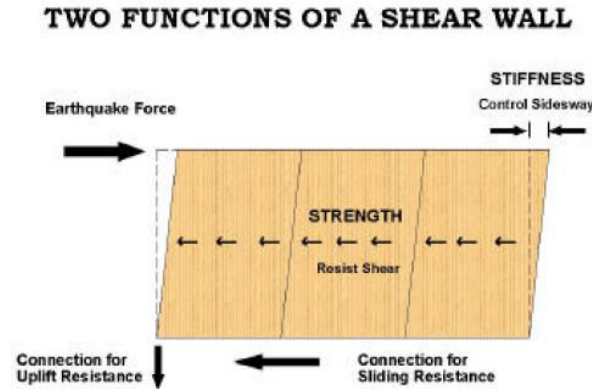
Type C: It is composed of soft soils. All soft soils other than SP with  $N < 10$ . The various possible soils are ; Silts of intermediate compressibility (MI). Silts of high compressibility (MH). Clays of intermediate compressibility (CI). Clays of high compressibility (CH). Silts and clays of intermediate to high compressibility (MI-MH or CI-CH). Silt with clay of intermediate compressibility (MI-CI). Silt with clay of high compressibility (MH-CH).





IV. SHEAR WALL

FUNCTIONS OF SHEAR WALL



Shear walls must provide the necessary lateral strength to resist horizontal earthquake forces. When shear walls are strong enough, they will transfer these horizontal forces to the next element in the load path below them. These other components in the load path may be other shear walls, floors, foundation walls, slabs or footings.

Shear walls also provide lateral stiffness to prevent the roof or floor above from excessive side-sway. When shear walls are stiff enough, they will prevent floor and roof framing members from moving off their supports. Also, buildings that are sufficiently stiff will usually suffer less nonstructural damage.

V. PROBLEM STATEMENT

The building considered here is a residential building Having G + 24 storied located in seismic zone V and for earthquake loading, the provisions of the IS:1893(Part1)- 2002 is considered. The plan of building is shown in figure. The plan dimension of the building is 20 m X 30 m. Height of each storey is 3m. The floor plans were divided into four by six bays in such a way that center to center distance between two grids is 5 m by 5 m respectively .

Total height of building	72.3 m		
Height of each story	3m		
Thickness of slab	125mm		
Grade of reinforcing steel	Fe500		
Density of concrete	25 KN/m <sup>3</sup>		
Grade of concrete for beam ,coulumn and shear wall	M25		
Seismic zone	V		
Seismic zone factor	0.36		
Soil condition	Hard	Medium	Soft
Soil interaction factor	1	2	3
Response reduction factor	4		
Importance factor	1.2		
Damping ratio	0.05		
Column size RCC	Ht 0 m to 30 m	700 m X 700 m	
	Ht 30m to 60 m	600 m X 600 m	
	Ht 60 m to 90 m	400m X400m	



Thickness of shear wall	300mm (Ht 0m to 27m)
	250mm (Ht 27m to 60m)
	150 mm (Ht 60 to 90 m)

**VI. LOAD COMBINATIONS**

The gravity loads and earthquake loads will be taken for analysis. The basic loads are Dead loads (DL), Imposed load (LL), Earthquake load (EQ) along X and Z in positive and negative direction. As per IS 1893 (Part I): 2002 Clause no. 6.3.1.2, the following Earthquake load cases have to be considered for analysis.

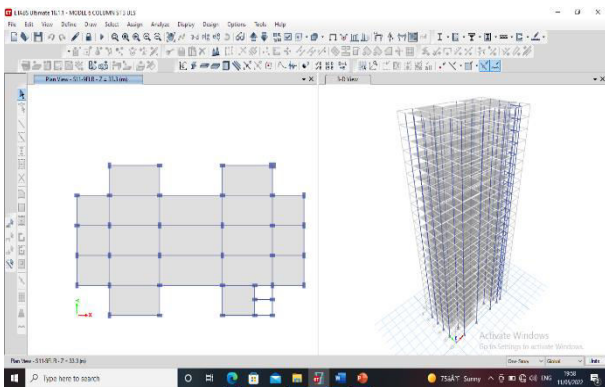
- I. 1.5(DL + LL)
- II. 0.9DL ± 1.5EQX
- III. 0.9DL ± 1.5EQZ
- IV. 1.5(DL ± EQZ)
- V. 1.5(DL ± EQX)
- VI. 1.2(DL + LL ± EQX)
- VII. 1.2(DL + LL ± EQZ)

CODAL PROVISIONS: -

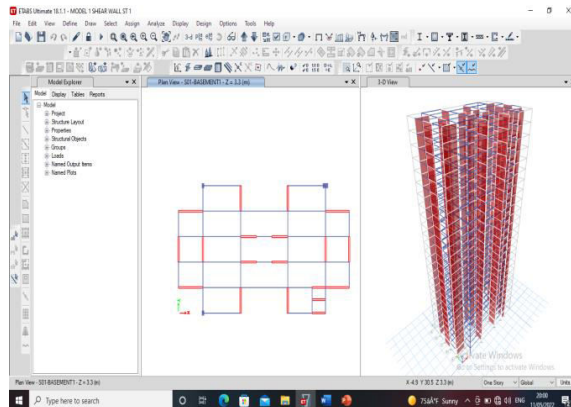
- 1. Dead Load – IS 875 Part I
- 2. Live Load – IS 875 Part II
- 3. Wind Load - IS 875 Part III
- 4. Seismic Analysis
  - a. IS 1893:2002 (Part 1) Main code that provides the seismic zone and specifies seismic design force. This depends on the mass and seismic coefficient of the structure; the latter in turn

**VII. MODELLING**

MODELS	SOIL TYPE	WITH/ WITHOUT SHEARWALL
MODEL 1	SOFT	WITH SHEAR WALL
MODEL 2	SOFT	WITHOUT SHEARWALL
MODEL 3	MEDIUM	WITH SHEAR WALL
MODEL 4	MEDIUM	WITHOUT SHEARWALL
MODEL 5	HARD	WITH SHEAR WALL
MODEL 6	HARD	WITHOUT SHEARWALL



COLUMN MODEL WITH 3 SOIL TYPES



SHEAR WALL MODEL WITH 3 SOIL TYPE

**VIII. RESULTS**

1. MODAL TIME PERIOD

TYPE OF BUILDING	SOIL I	SOIL II	SOIL III
SHEAR WALL	2.775	2.817	2.94
COLUMN	3.564	3.664	3.511

2. BASE SHEAR DETAILS

Base Shear	SOIL I	SOIL II	SOIL III
SHEAR WALL	6545.48	8099	11250
COLUMN	5850	6719	7798

3. DISPLACEMENT RESULTS

DISPLACEMENT	SOIL I	SOIL II	SOIL III
SHEAR WALL	19.37	18.97	14.16
COLUMN	15.19	16	15.11

4. STORY DRIFT

STORY DRIFT	SOIL I	SOIL II	SOIL III
SHEAR WALL	0.000351	0.000296	0.000253
COLUMN	0.000312	0.000297	0.000280

**IX. CONCLUSIONS**

- In building having no shear wall drift increases in initial 4 or 5 stories there after it remain constant about 2/3 of total height and then it decreases. A kink is observed where column sections are changed.
- Irrespective of type of provision of shear wall. In case of 70m height building drift increases gradually up to 1/2 of total height and there after it is almost constant in all the cases. In all the cases it is well within permissible limit.
- In case where full shear wall and Stepped shear wall show proper drift reduction factor upto 3/4 of total height.
- As we seen in results base of shear wall is increasing in large scale compare to column base reaction
- Also the time period is also more for the column compare to the shear wall design
- As we get values of percentage reinforcement of the building which is required for the construction for shear wall and column , in that case shear wall requires more percentage reinforcement in building which is also not economical
- But after seeing all results coming from the project we conclude that shear wall is better to oppose the lateral forces



as compare to the column

- And column are better to maintain base reactions for footings of building

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